

WHAT IS CLAIMED IS:

1. A method for evaluating thermal comfort of a structure constituted by a first, second, ... n-th part (n is a natural number of at least two) wherein at least one  
5 of these parts is a translucent member for introducing light to the inside, the method for evaluating thermal comfort of a structure comprising:

a step (a) of preparing data (1) of the material property of the first part, the material property of the  
10 second part, ... the material property of the n-th part, and data (2) of an amount of solar radiation passing through the translucent member to reach a measuring device having a shape imitating a human body part, an amount of solar radiation to the structure, an amount of  
15 convection heat transfer in the structure, an amount of radiation heat transfer in the structure, humidity in the structure and/or a thermo-regulating function of the measuring device, and calculating at least one of the amount of heat loss from the surface of the measuring  
20 device, the temperature of the measuring device and/or the wettedness at the surface of the measuring device based on at least one in each of data (1) and (2), and

a step (b) of calculating a thermal comfort index of the measuring device by using a result of the above  
25 calculation.

2. The method for evaluating thermal comfort of a structure according to Claim 1, wherein said step (b)

comprises:

selecting and reading the material property  
registered in said data base for each part, and preparing  
at least one combination among registered material  
5 properties,

calculating, in combined operations, at least two of  
the calculation of the amount of solar radiation passing  
through the translucent member to reach a measuring  
device having a shape imitating a human body part, the  
10 calculation of the amount of solar radiation to the  
structure, the calculation of the amount of convection  
heat transfer in the structure, the calculation of the  
amount of radiation heat transfer in the structure, the  
calculation of the humidity in the structure and/or the  
15 calculation of the thermo-regulating function of the  
measuring device with respect to each combination of  
material properties thus prepared,

calculating at least one of the amount of heat loss  
from the surface of the measuring device, the temperature  
20 of the measuring device and/or the wettedness at the  
surface of the measuring device,

calculating at least one among the amount of heat  
loss from the surface of the measuring device, the  
temperature of the measuring device and/or the wettedness  
25 at the surface of the measuring device, and

calculating the thermal comfort index of the  
measuring device by using a result of the above

calculation.

3. The method for evaluating thermal comfort of a structure according to Claim 1, wherein said material property is the material property of a material of each of said parts or a value indicating a shape of each of said parts.

4. The method for evaluating thermal comfort of a structure according to Claim 1, wherein said measuring device includes a heat source.

5. The method for evaluating thermal comfort of a structure according to Claim 1, wherein said measuring device is a thermal manikin having a thermo-regulating function.

6. The method for evaluating thermal comfort of a structure according to Claim 5, wherein the thermo-regulation of the thermal manikin is carried out by (a) adjusting an amount of heat generated from a heat source so that the temperature of a skin layer of the thermal manikin is constant, (b) making the heat generated from a heat source constant, or (c) balancing the temperature of the skin layer of the thermal manikin with a sensible heat loss at the surface of the skin layer in response to the ambient circumstances of the thermal manikin.

7. The method for evaluating thermal comfort of a structure according to Claim 5, wherein said step (b) comprises:

a step (b1) of preparing a surface model of the

structure by dividing the shape of inner surface of the structure into a plurality of surface elements, preparing a surface model of a human body by dividing the shape of outer surface of the manikin in the structure into a plurality of surface elements and preparing an indoor space model by dividing the indoor space between the structure and the thermal manikin into a plurality of cubic elements,

a step (b2) of classifying the surface model of human body into a plurality of parts corresponding to parts of the thermal manikin, and installing a thermo-regulation model for balancing heat generated in the thermal manikin with heat radiated from the thermal manikin in each of the parts,

a step (b3) of obtaining an amount of heat transported by the solar radiation passing through the translucent member to reach the surface model of human body and the structure, convection in the indoor space, radiation from the surface model of human body and radiation from the surface model of the structure by a numerical simulation based on the calculation of the indoor space model, and calculating temperature and air flow fields in the indoor space based on a result of the simulation,

a step (b4) of calculating at least one of the amount of heat loss from the skin surface of the thermal manikin, the temperature at the skin of the thermal manikin and/or

the wettedness at the surface of the thermal manikin by a numerical simulation using the thermo-regulation model based on the temperature and air flow fields, the humidity around the thermal manikin, an amount of clothing on the thermal manikin and/or an amount of the activity of the thermal manikin, and

a step (b5) of calculating a thermal comfort index at the skin surface of the thermal manikin by using at least one of the heat loss, the skin temperature and/or the wettedness.

8. The method for evaluating thermal comfort of a structure according to Claim 1, wherein the translucent member is at least one member selected from the group consisting of a single glazing glass sheet, an insulated glazing glass sheet, a laminated glass sheet formed by sandwiching an organic resin layer by a plurality glass sheets, an organic resin layer, an organic resin plate and an organic glass sheet.

9. An assisting method for designing a structure in consideration of thermal comfort, the structure being constituted by a first, second, ... the n-th part (n is a natural number of at least two) wherein at least one of these parts is a translucent member for introducing light to the inside, the assisting method for designing a structure comprising:

a step (a) of preparing at least one candidate value for each of the material property of a first part, the

material property of a second part, ... the material property of an n-th part, and registering candidate values of material properties of these parts in a predetermined data base,

5       a step (b) of selecting and reading the material property registered in said data base for each part, and preparing at least one combination among the registered material properties,

          calculating at least one of the amount of heat loss  
10   from the surface of the measuring device, the temperature of the measuring device and/or the wettedness at the surface of the measuring device based on at least one in each of data (1) combinations of material properties thus prepared and (2) an amount of solar radiation passing  
15   through the translucent member to reach the measuring device having a shape imitating a human body part, an amount of solar radiation to the structure, an amount of convection heat transfer in the structure, an amount of radiation heat transfer in the structure, humidity in the  
20   structure and/or a thermo-regulating function of the measuring device, and

          calculating a thermal comfort index of the measuring device by using a result of the above calculation, and

          a step (c) of selecting a combination of material  
25   properties having a value closest to the optimum thermal comfort index.

10. The assisting method for designing a structure in

consideration of thermal comfort according to Claim 9,  
wherein said step (b) comprises:

selecting and reading, for each part, the material  
property registered in said data base, and preparing at  
5 least one combination among registered material  
properties,

calculating, in combined operations, at least two of  
the calculation of the amount of solar radiation passing  
through the translucent member to reach the measuring  
10 device having a shape imitating a human body part, the  
calculation of the amount of solar radiation to the  
structure, the calculation of the amount of convection  
heat transfer in the structure, the calculation of the  
amount of radiation heat transfer in the structure, the  
15 calculation of the humidity in the structure and/or the  
calculation of the thermo-regulating function of the  
measuring device with respect to each combination of  
material properties thus prepared,

calculating at least one of the amount of heat loss  
20 from the surface of the measuring device , the  
temperature of the measuring device and/or the wettedness  
at the surface of the measuring device,

calculating at least one among the amount of heat  
loss from the surface of the measuring device, the  
25 temperature of the measuring device and/or the wettedness  
at the surface of the measuring device, and

calculating the thermal comfort index of the

measuring device by using a result of the above calculation.

11. The assisting method for designing a structure in consideration of thermal comfort according to Claim 9, wherein said material property is the material property of a material for each of said parts or a value indicating a shape of each of said parts.

12. The assisting method for designing a structure in consideration of thermal comfort according to Claim 9, wherein said measuring device includes a heat source.

13. The assisting method for designing a structure in consideration of thermal comfort according to Claim 9, wherein said measuring device is a thermal manikin having a thermo-regulating function.

14. The assisting method for designing a structure in consideration of thermal comfort according to Claim 13, wherein the thermo-regulation of the thermal manikin is carried out by (a) adjusting an amount of heat generated from a heat source so that the temperature of a skin layer of the thermal manikin is constant, (b) making the heat generated from the heat source constant, or (c) balancing the temperature of the skin layer of the thermal manikin with a sensible heat loss at the surface of the skin layer in response to the ambient circumstances of the thermal manikin.

15. The assisting method for designing a structure in consideration of thermal comfort according to 13, wherein



said step (b) comprises:

a step (b1) of preparing a surface model of the structure by dividing the shape of inner surface of the structure into a plurality of surface elements, preparing  
5 a surface model of human body by dividing the shape of outer surface of the manikin in the structure into a plurality of surface elements and preparing an indoor space model by dividing the indoor space between the structure and the thermal manikin into a plurality of  
10 cubic elements,

a step (b2) of classifying the surface model of human body into a plurality of parts corresponding to parts of the thermal manikin, and installing a thermo-regulation model for balancing heat generated in the thermal manikin  
15 with heat radiated from the thermal manikin in each of the parts,

a step (b3) of obtaining an amount of heat transported by the solar radiation passing through the translucent member to reach the surface model of human  
20 body and the structure, convection in the indoor space, radiation from the surface model of human body and radiation from the surface model of the structure by a numerical simulation based on the calculation of the indoor space model, and calculating temperature and air  
25 flow fields in the indoor space based on a result of the simulation,

a step (b4) of calculating at least one of the amount

of heat loss from the skin surface of the thermal manikin,  
the temperature at the skin of the thermal manikin and/or  
the wettedness at the surface of the thermal manikin by  
the numerical simulation using the thermo-regulation  
5 model based on the temperature and air flow fields, the  
humidity around the thermal manikin, an amount of  
clothing on the thermal manikin and/or an amount of the  
activity of the thermal manikin, and

a step (b5) of calculating a thermal comfort index at  
10 the skin surface of the thermal manikin by using at least  
one of the heat loss, the skin temperature and/or the  
wettedness.

16. The assisting method for designing a structure in  
consideration of thermal comfort according to Claim 9,  
15 wherein the translucent member is at least one member  
selected from the group consisting of a single glazing  
glass sheet, an insulated glazing glass sheet, a  
laminated glass sheet formed by sandwiching an organic  
resin layer by a plurality glass sheets, an organic resin  
20 layer, an organic resin plate and an organic glass sheet.

17. The assisting method for designing a structure in  
consideration of thermal comfort according to Claim 9,  
wherein the material property of the translucent member  
is determined by a combination of the transmittance of  
25 solar radiation, the absorptance of solar radiation, the  
emissivity and the overall heat transfer coefficient.

18. The assisting method for designing a structure in

consideration of thermal comfort according to Claim 9,  
wherein said thermal comfort index is a comfort index  
based on equivalent temperature, standard effective  
temperature, predicted mean vote or a modified value of  
5 the standard effective temperature.

19. The assisting method for designing a structure  
according to Claim 9, wherein said structure has at least  
one selected from the group consisting of a heating,  
ventilation and air conditioning system, a radiation  
10 cooling/heating panel system, a ventilation system and a  
humidity controlling system, and said thermal comfort  
index is calculated in consideration of the selected  
system.

20. A thermal comfort evaluation program for a structure  
15 constituted by a first, a second, ... an n-th part (n is a  
natural number of at least two) wherein at least one of  
these parts is a translucent member for introducing light  
to the inside, the thermal comfort evaluation program  
comprising program codes for instructing to a computer to  
20 realize the steps described in Claim 1.

21. A thermal comfort evaluation system for a structure  
constituted by a first, a second, ... an n-th part (n is a  
natural number of at least two) wherein at least one of  
these parts is a translucent member for introducing light  
25 to the inside, the thermal comfort evaluation system for  
a structure comprising:

means for preparing data (1) of the material property

of the first part, the material property of the second part, ... the material property of the n-th part, and data (2) of an amount of solar radiation passing through the translucent member to reach a measuring device having a shape imitating a human body part, an amount of solar radiation to the structure, an amount of convection heat transfer in the structure, an amount of radiation heat transfer in the structure, humidity in the structure and/or a thermo-regulating function of the measuring device, and calculating at least one of the amount of heat loss from the surface of the measuring device, the temperature of the measuring device and/or the wettedness at the surface of the measuring device based on at least one in each of data (1) and (2), and

means for calculating a thermal comfort index of the measuring device by using a result of the above calculation.

22. An assisting program for designing a structure constituted by a first, a second, ... an n-th part (n is a natural number of at least two) wherein at least one of these parts is a translucent member for introducing light to the inside, the assisting program for designing a structure comprising program codes for instructing to a computer to realize the steps described in Claim 9.

23. An assisting system for designing a structure constituted by a first, a second, ... an n-th part (n is a natural number of at least two) wherein at least one of

these parts is a translucent member for introducing light to the inside, the assisting system for designing a structure comprising:

(a) means for preparing at least one candidate value  
5 for each of the material property of the first part, the material property of the second part, ... the material property of the n-th part, and registering candidate values of material properties of these parts in a predetermined data base,

10 (b) means for selecting and reading the material property registered in said data base for each part and preparing at least one combination among the registered material properties,

calculating at least one of the amount of heat loss  
15 from the surface of the measuring device, the temperature of the measuring device and/or the wettedness at the surface of the measuring device based on at least one in each of data (1) combinations of material properties thus prepared and (2) an amount of solar radiation passing  
20 through the translucent member to reach the measuring device in a form of a human body part, an amount of solar radiation to the structure, an amount of convection heat transfer in the structure, an amount of radiation heat transfer in the structure, humidity in the structure  
25 and/or a thermo-regulating function of the measuring device, and

calculating a thermal comfort index of the measuring

device by using a result of the above calculation, and

(c) means for selecting a combination of material properties having a value closest to the optimum thermal comfort index.